U.S. Department of Energy

Office of Electricity Delivery & Energy Reliability

Superconductivity Program

Overview

High Temperature Superconductivity (HTS) has the potential to play an important role in the future of our nation's electricity grid. The aging of the nation's utility infrastructure has created an opportunity for the development of new transmission technologies, and there is an unprecedented opportunity in the coming years for rapid market penetration of HTS power equipment to replace existing transmission equipment to help expand grid capacity. For example, DOE estimates that about 2,200 miles of existing underground cables are quickly becoming outdated and could be replaced with HTS lines that may carry two to five times the power within the same duct size.

The efforts of DOE's Superconductivity Program focus on partnerships with industry in the development of new HTS technologies. The program supports technology research into advanced wire materials and processes. In addition, the Program conducts industry-led systems research, which tests device-specific electric power applications using HTS wires available today, in an attempt to accelerate the development of these products.

Program Areas

Superconductivity Partnerships with Industry

The Superconductivity Program works through the Superconductivity Partnerships with Industry (SPI) to accelerate the development of HTS technologies. Through the SPI, vertically integrated teams, consisting of representatives from utilities, equipment and wire manufacturers, and national laboratories, work together with DOE support to develop HTS electric power equipment such as transmission lines, motors, generators, transformers, and fault-current limiters. DOE is currently working through the SPI with eight partnerships that are focused on developing and testing first-of-a-kind HTS technologies.

Strategic Research

The Department of Energy is working to promote advanced, cost-shared research activities that will lead to further development of HTS. For this, industry-university laboratory research focuses on the stability and normal zone propagation properties of second-generation wires; researches and develops cryogenic dielectric materials; and investigates alternate processes and wire geometries that may lead to an improved performance cost ratio for second-generation conductors. Research in this area may leverage funding from the DOE Office of Science to better understand the technical challenges associated with developing HTS. Activities also include close communication, systems analysis, and outreach with stakeholders to further HTS research requirements.

Second-Generation Wire Development

The Department of Energy has teamed with industrial consortia to research and develop high-performance, low-cost, second-generation HTS wire. This part of the Program addresses issues such as increasing engineering current density, improving fluxpinning properties in strong magnetic fields, and reducing alternating current losses through materials and processing research.

Mission

To work in partnership with industry to develop high-temperature superconducting wire and perform other research and development activities leading to the commercialization of high-temperature superconductivity (HTS) electric power applications by U.S. companies.

Program Areas

Activities within the Superconductivity for Electric Systems Program are organized into three categories. See the box to left to read more.

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First prototype cable made by Ultera with second-generation HTS wire made by American Superconductor carries commercial levels of electric current.

Success Stories

Southwire Project

"This work will help provide solutions to power quality and electric reliability problems, and bring the benefits of superconductivity more quickly to the U.S. electrical industry and the American people. Highly visible public-private partnerships such as this will encourage industry to develop and test prototype equipment for the U.S. electric power system and expand DOE's research and development of superconductivity to support the President's National Energy Plan."

— *Secretary of Energy Spencer Abraham, announcing joint DOE/industry superconductivity projects in 2001*

As part of the Superconductivity Partnerships with Industry, the Superconductivity Program is partnering with Southwire Company and Oak Ridge National Laboratory (ORNL) in one of the world's first cable demonstrations of HTS wires. As part of the demonstration, three facilities at Southwire's 2,000-employee Carrollton, Georgia, plant now receive electricity through an HTS power system. This demonstration is a groundbreaking technological achievement, as it is the world's first HTS application for industrial use.

The Carrollton facility's 30-meter HTS line was built by Southwire after joint research and development of a 5-meter version that was tested at ORNL. The demonstration was funded under a cost-sharing arrangement with DOE's Superconductivity Program. The project went online in February 2000 and has provided 100% of customer load for over 22,000 hours.

Since the beginning of its operation, the Southwire line has been the subject of a wide variety of research into high-temperature superconductivity. Recent accomplishments include the continued monitoring of the 30-meter line at Carrollton, the testing of a triaxial 5-meter cable with three-phase terminations at ORNL, and research into improved performance of cryogenic dielectric materials and cooling systems. The electrical utility partners in this effort are Southern Company, Georgia Transmission Corp. and Southern California Edison.

The success of the Carrollton collaboration has led to a new project with an HTS line that will be ten times longer and carry three times the current of the Carrollton project. This new project—announced by the Superconductivity Program in December 2002 and led by Ultera, in a joint venture between Southwire and nkt cables—will design and produce a 300-meter HTS cable that will be installed during late 2005 in an electricity distribution system inside a substation operated by American Electric Power (AEP) in Columbus, Ohio.

Finally, in April 2003 the Superconductivity Program announced the start of yet another cost-shared cable project at a Long Island Power Authority substation. The project will extend HTS cable technology to the highest voltage (138 kV) and longest length (2,000-foot transmission circuit) of any planned U.S. cable installation. The project will be managed by American Superconductor Corporation.

Southwire HTS site in Carrollton, Georgia.

Southwire 30-meter cable installation (termination end).

The ability of superconductor cables to transmit substantially more power than conventional cables in the same right-of-way will help utilities meet customers' growing demands for electricity. HTS technology is a powerful new tool for relieving grid constraints reliably and unobtrusively.